CHAPTER 2

PRESSURE REGULATION ALTERNATIVES

2-1. **General.** The pressure levels for the distribution system are set by chapter 4. Alternative means to maintain these pressures consist of gravity systems, direct pressure systems, pneumatic system or a combination of the above. Pressure regulating valves are available to reduce system pressures if required.

2-2. **Gravity pressure systems.** This is the preferred method of maintaining adequate pressure in the system. Gravity pressure systems are inherently associated with elevated storage. A storage facility provides a reservoir in which the inflow and outflow of water can better match the hourly consumer demand and can be a supply source during emergency situations such as interruptions in the normal supply service or heavy demands for fire fighting. Reservoirs should be located within or adjacent to load centers (i.e., areas of high demand) of the distribution grid to meet water demands in those areas without causing high velocities and head losses in the distribution mains. The pressure in the system supplying water to the storage facility needs to be sufficient to fill the reservoir. If it is not, booster pumps may be required. Two types of tanks may be used in a gravity pressure system: elevated and ground storage tanks.

a. Elevated tank. Where ground elevations are relatively uniform, an elevated tank will be considered to maintain pressure in lieu of ground storage facilities where practical. The tank will be adequately sized in accordance with TM 5-813-4/AFM 88-10, Vol. 4. The height of the tank will be determined from the topography of the area served, the height of the buildings and the pressure losses in the distribution system. Standard and special designs are available in sizes up to 3,000,000 gallons. Standard design will be utilized except where special conditions warrant other designs. Special designs on Air Force projects will be subject to approval by HQ USAF/LEEEU, Washington, D.C. 20332. In addition, altitude valves, check valves and shut off valves are necessary to control the level of water in the tank and to provision or isolate portions of the distribution system during emergencies. These are to be contained in a valve pit near the base of the tank, protected from freezing, and will provide for appropriate connections to the distribution system.

b. Ground level storage. Ground level storage can consist of steel standpipes and steel or concrete ground storage reservoirs. These are to be designed where there is sufficient difference in ground elevation to maintain adequate pressure in the distribution system. Concrete reservoirs can be designed for any size system, but are more often used for larger sizes, i.e., those exceeding 1,000,000 gallons. Standpipes of 6 to 20 feet in diameter may be installed for small systems. If the differences in natural ground elevations is insufficient to maintain pressures, booster pumps may be required in conjunction with ground storage to increase system pressure.

c. Sizing of storage volume. The maximum and minimum elevations of water in the tank determine the pressure in the distribution system and should be designed accordingly. The required volume determines the surface area of the tank which is based on daily use and fire flow demand. Refer to TM 5-813-4/AFM 88-10, Vol. 4.

2-3. **Direct-pressure systems.** A direct pressure distribution system is one in which no elevated storage is provided, and the required distribution pressures are maintained only by pumping facilities. A ground level storage tank may be provided to serve as an intake supply for the pumping facilities. Direct-pressure distribution systems will be considered only where the military use or special requirements will not permit the utilization of elevated storage tanks. Caution must be used in design to reduce surge pressure and compensate for variable volume demands. Provisions must be made to ensure the availability of sufficient supply to meet fire and emergency demands. The pumping facilities in a direct-pressure system must have firm capacities equal to or greater than the peak demand rates exerted on the system. The firm capacity of a pumping facility is the total pumping capacity with the largest pump out of service. Automatic controls are available which react to pressure sensors and cycle the pumps according to a sequence which may be predetermined by the operator.

a. Pumping stations. For variable flow requirements, consideration will be given to variable speed pumps, multiple pumps with stage control, flow regulating valves, or flow recirculation. The usual location is at the supply and treatment facility. Additional units may be located within the distribution system. Consideration should be given to providing a by-pass around pumps in the distribution system so that some flow may be maintained even when the pump is out of service. The pumps and associated equipment shall be contained in a vault or pump house to protect the equipment from the environment.

b. Line boosters. Line booster stations may be designed where system head loss dictates their use. This may include distribution system areas that are remote from pumping stations, high rise building areas where normal pressure is inadequate, localized areas of higher elevation or extensions to existing distribution system where the cost of additional elevated storage is prohibitive. These pumps may be submersible turbine pumps, mounted in housings which can be installed in a water main much the same as a regular section of pipe. The pumps may be buried underground. As with all electrical-mechanical devices, they are subject to maintenance needs. Therefore, provision must be made for future maintenance which may include excavation of the installation. Other types of pumps, most commonly centrifugal, may be installed in a vault or pump house. This installation is designed as any other pump station.

c. Multiple pressure levels. In multiple pressure level distribution systems, where pumps are installed in the system, the designer should check for circulation around the pumps. If recirculation of water from the high pressure system to the low pressure system is possible, which would cause the water to be pumped twice, distribution line valves must be closed or check valves should be installed.

2-4. Pneumatic System. A hydropneumatic tank "riding" on the system serves two functions. First, it can act as a reservoir of water for emergency supply for a short period of time such as a supply for a sprinkler head; second, it can act as an air spring or piston and is a reservoir of stored energy to maintain pressure in the system and help avoid short-cycling of the pumps.

a. Applicability. Hydropneumatic distribution systems are applicable where demands are less than 500 gallons per minute. Hydropneumatic tanks will be designed and constructed in accordance with ASME Boiler and Pressure Vessel Code, Section VIII.

b. Pressure settings. The low pressure setting on the hydropneumatic tank is determined by distribution system requirements. The recommended minimum operating pressure is 30 pounds per square inch (psi), at the highest ground elevation in the distribution system. The high pressure setting on the hydropneumatic tank is dependent on the maximum allowable pressure in the distribution system. The recommended maximum operating pressure is 100 psi. For a specific application, the pressure variation in the tank is normally about 20 psi. The low water level (water level at the low pressure setting) must be high enough to provide a water seal. At the low water level, the water remaining in the tank should be at least 10 percent of the capacity of the tank. The high water level should be calculated to provide maximum efficiency. The pumps will be sized to deliver 125 percent of the calculated peak demand of the distribution system. The tank size will be at least 10 times the rated capacity of the pump. The tank will be sized so that the pump cycles not less than 4 times per hour, nor more than 10 times per hour, unless the pump motor horse-power rating exceeds 50, in which case the maximum number of cycles will be 6 per hour. Completely automatic hydropneumatic tank controls are available to maintain proper operating conditions (correct air-water volume ratios) during each pump cycle. An auxiliary air compressor-type, air charging system will be used for tanks larger than 750 gallons and pressures higher than 75 psi. An air volume control valve operation will be used to maintain correct air-water volume ratios for all other applications.

2-5. Pressure regulating valves. Pressure regulating valves function to reduce an existing high pressure to a uniform downstream pressure. Although this function can be accomplished by partially closed line valves, this method requires manual operation or motorized operators with remote control and continuous monitoring. Automatic pressure reducing and sustaining valves are available which react to distribution system pressures. These valves operate on two principles.

a. Direct action. A direct-acting regulator cannot regulate pressure closely if considerable range of variation between the wide open and nearly closed positions is required. The regulated pressure is influenced considerably by variations in the high-pressure side, and a great differential must always exist between the high side and the regulated side. Such regulators give excellent service in small sizes where accurate regulation is not important or where the rate of flow is fairly steady.

b. Pilot operated. In water distribution regulation, it is important to sustain the pressure as load increases. With pilot-operated reducing valves, it is possible to get extremely close regulations at any flow up to the full capacity of the valve wide open. Pilot-operated valves may chatter and perform improperly when flow is very small and the disc or piston is close to the seat. Each valve must be provided with two gate valves, permitting it to be shut off for repairs without interfering with other valves. Pressure regulators, like other automatic equipment, should be inspected weekly to insure good operation and discover the need for preventive maintenance before a serious breakdown occurs.